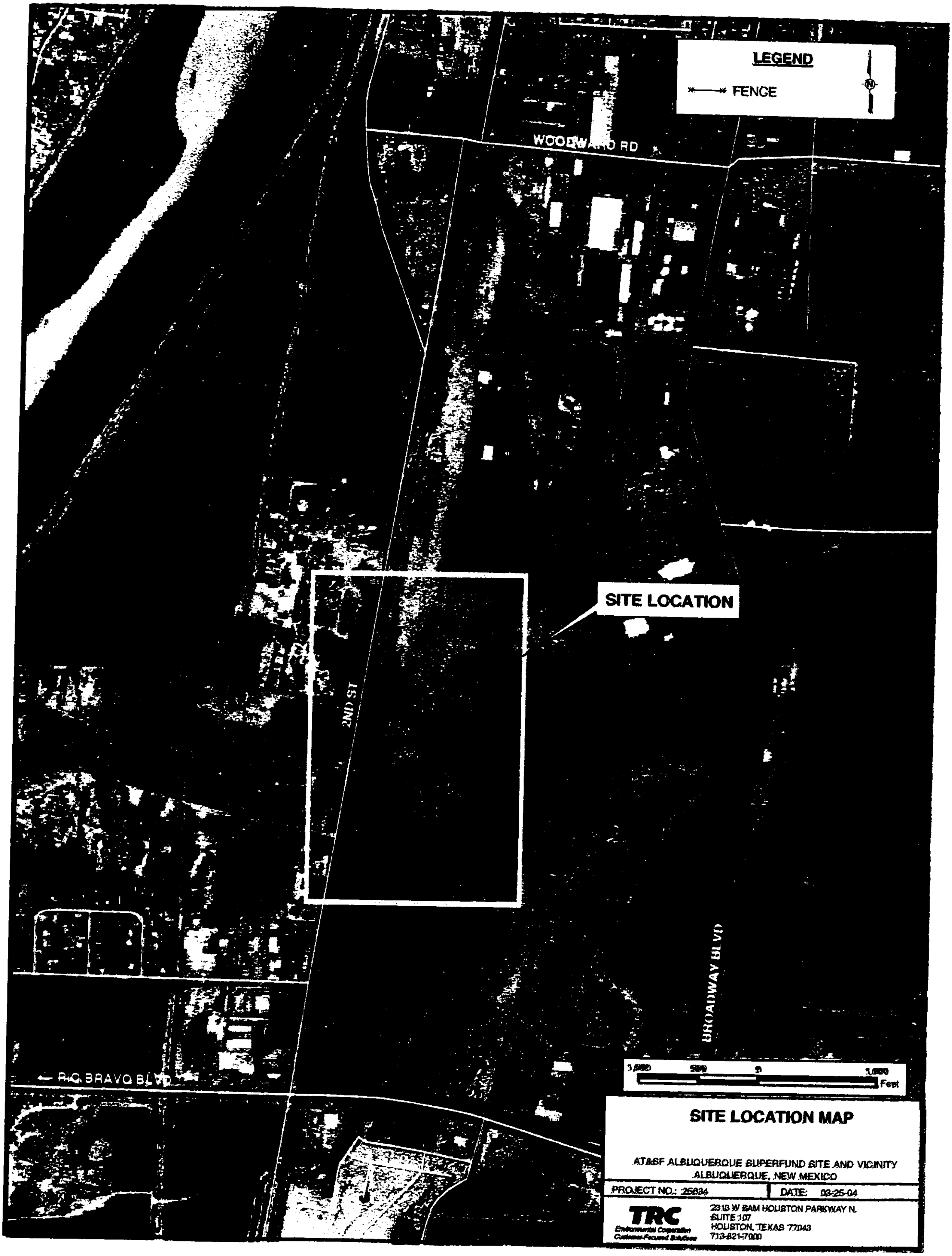
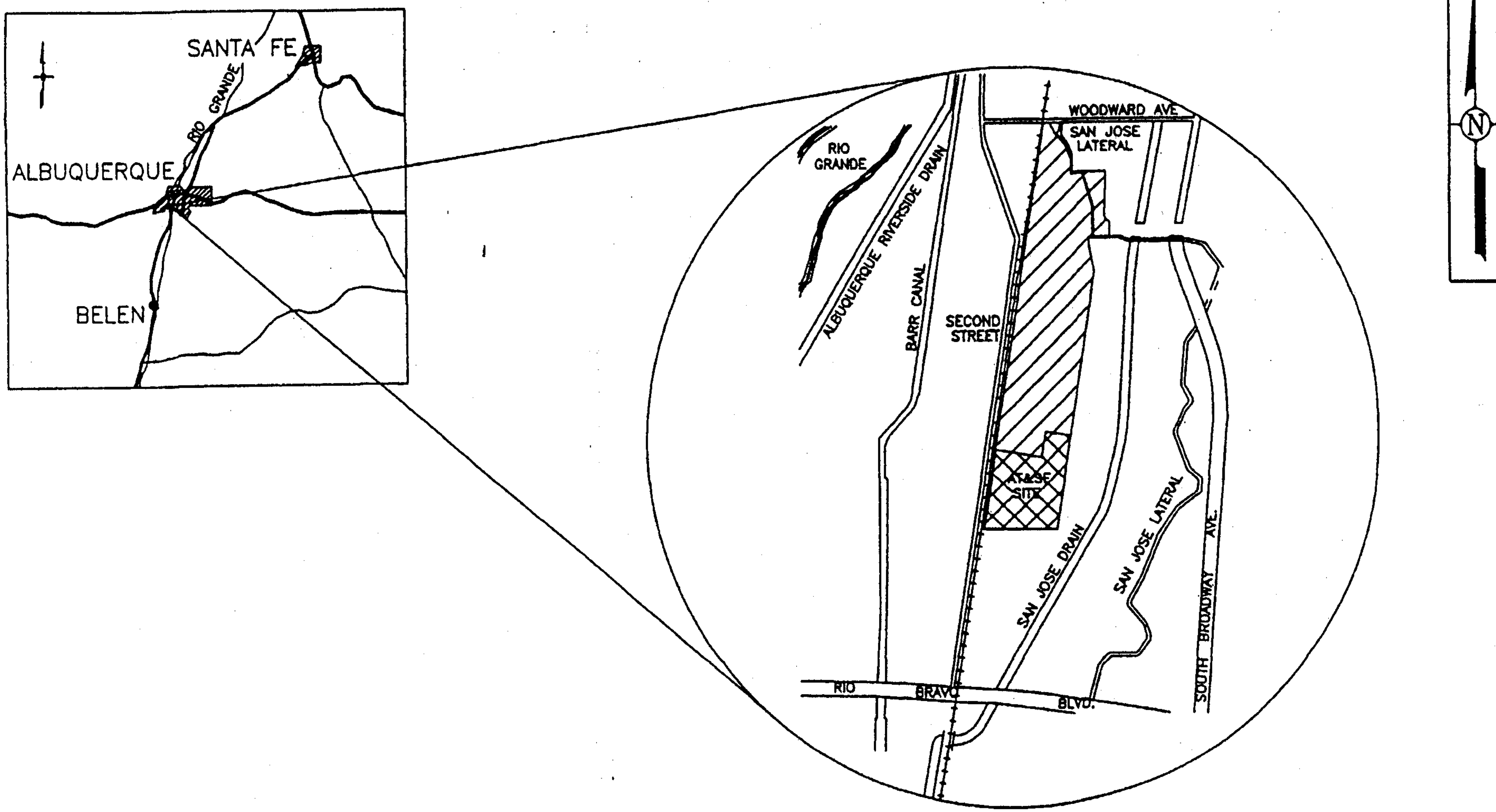
Appendix C


LEGEND
FENCE
WOODWARD RD
SITE LOCATION
2ND ST
BROADWAY BLVD
RIO BRAVO BLVD
Feet
SITE LOCATION MAP
AT&SF ALBUQUERQUE SUPERFUND SITE AND VICINITY
ALBUQUERQUE, NEW MEXICO
PROJECT NO.: 25834
DATE: 03-25-04
TRC
2313 W SAM HOUSTON PARKWAY N.
SUITE 107
HOUSTON, TEXAS 77043
713-821-7000

FIGURES

HOU J:\BNSF - Albuquerque\Drawings\Working\Soil Feasibility Study\25634_SOILFS_1-1.dwg Model 04/12/01 09:11 B.C.



NOT TO SCALE

LEGEND:

EXTENT OF FORMER TIE TREATING PLANT AND RAIL YARD

AREA OF FORMER TIE TREATING PLANT

SITE LOCATION MAP

AT & SF SITE
ALBUQUERQUE, NEW MEXICO

TRC

FIGURE 1-1

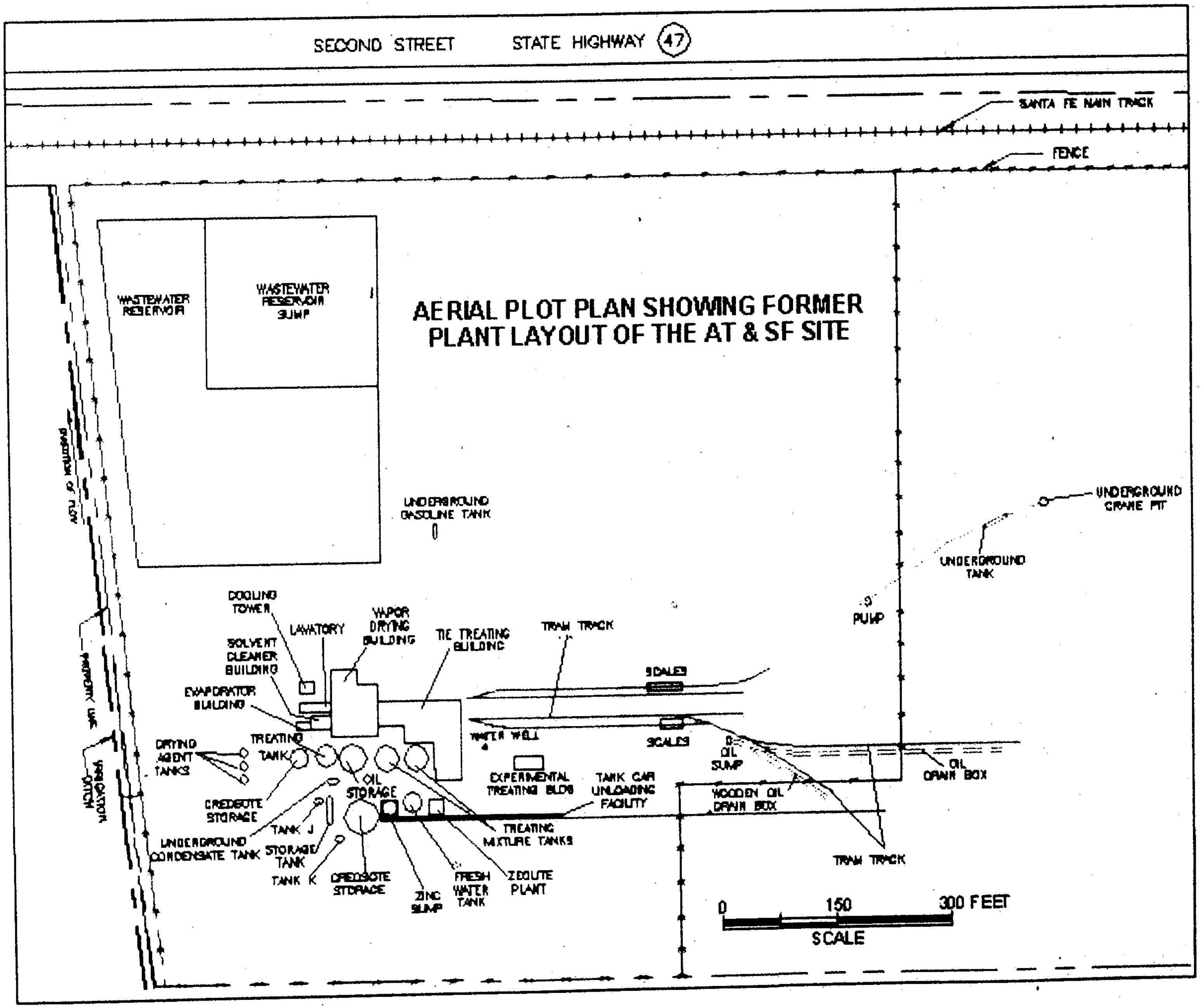


Figure 2 – Historical Site Layout Map

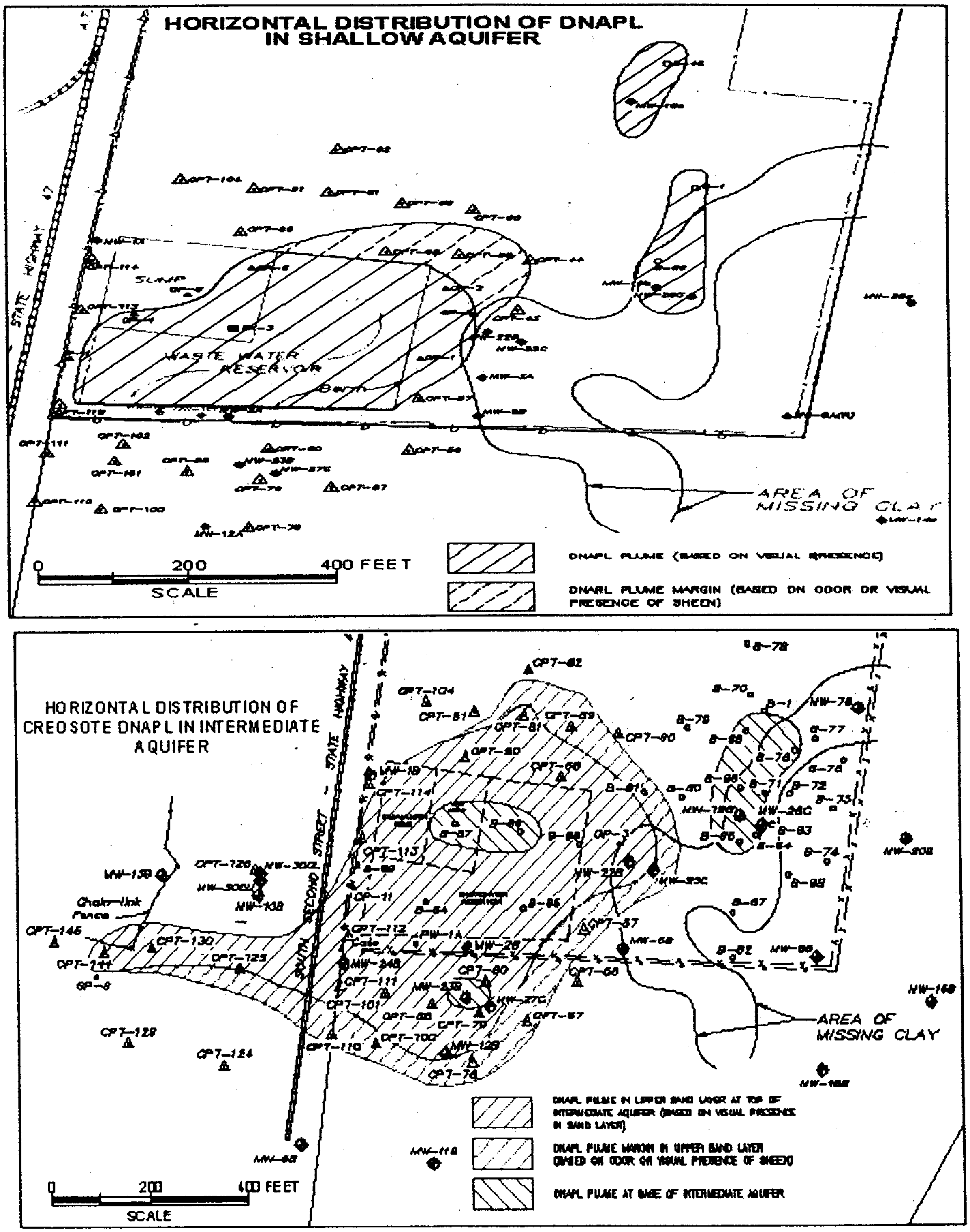


Figure 3 – DNAPL Distribution Map

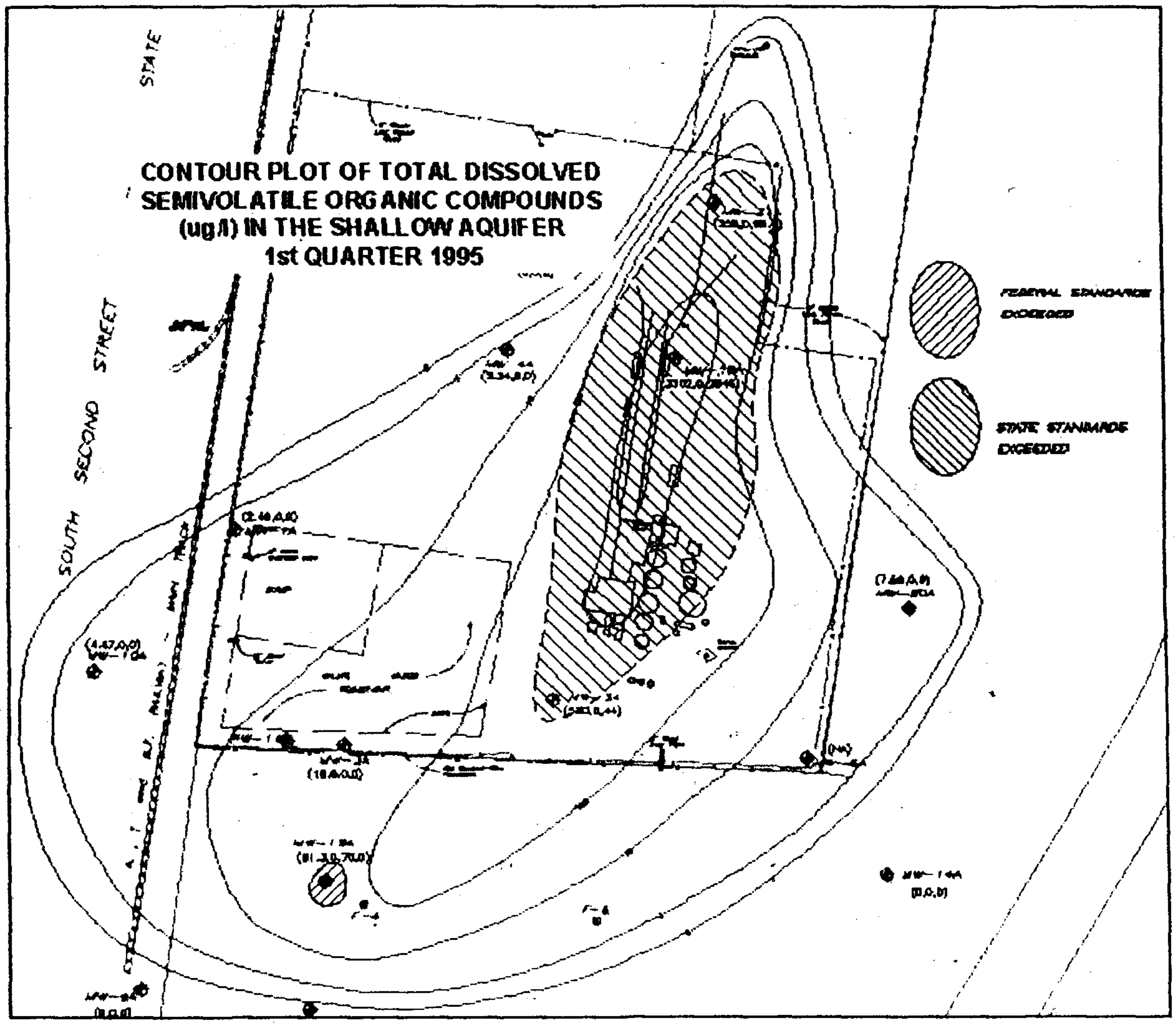


Figure 4 – Shallow Aquifer Contamination

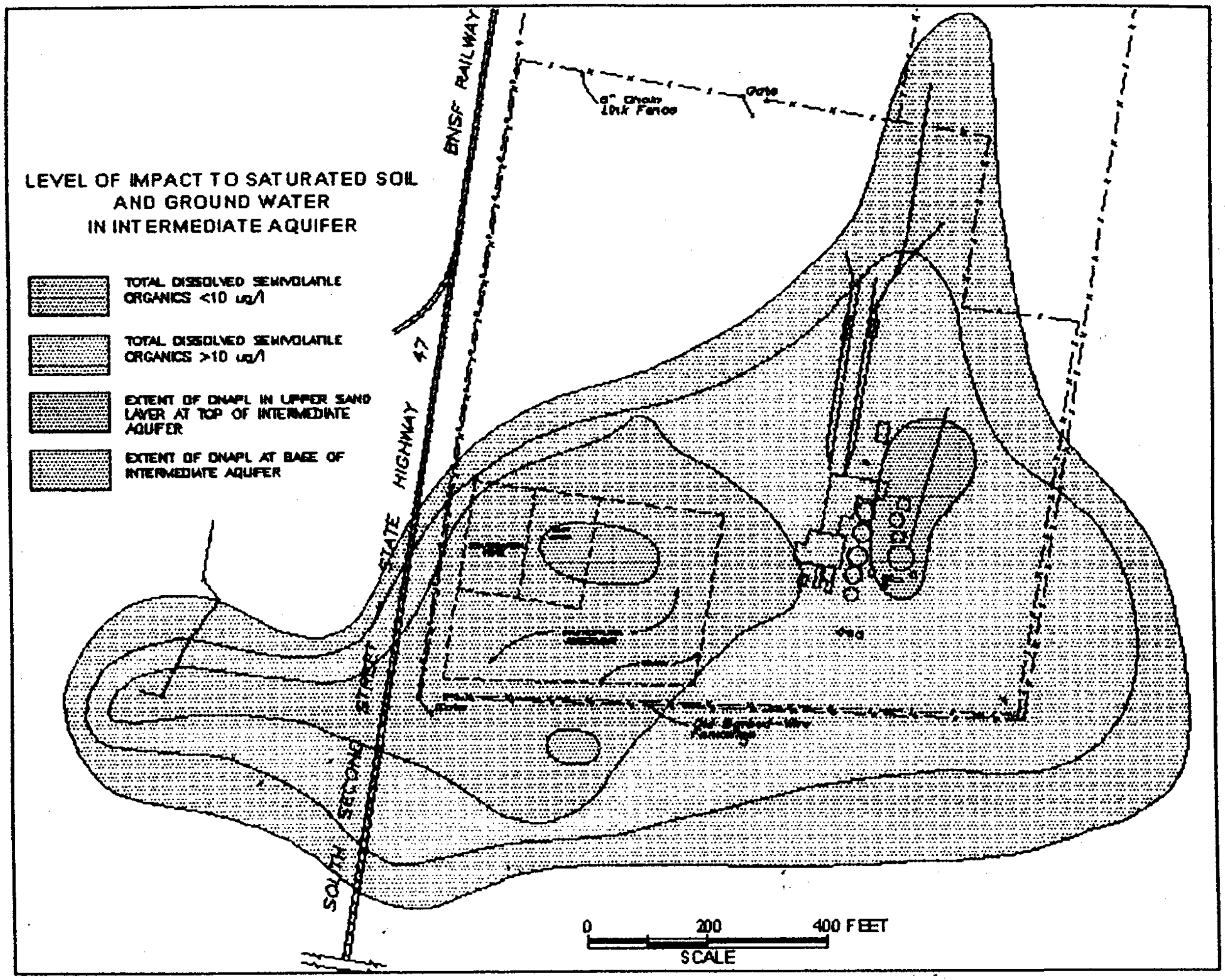


Figure 5 – Intermediate Aquifer Contamination Map

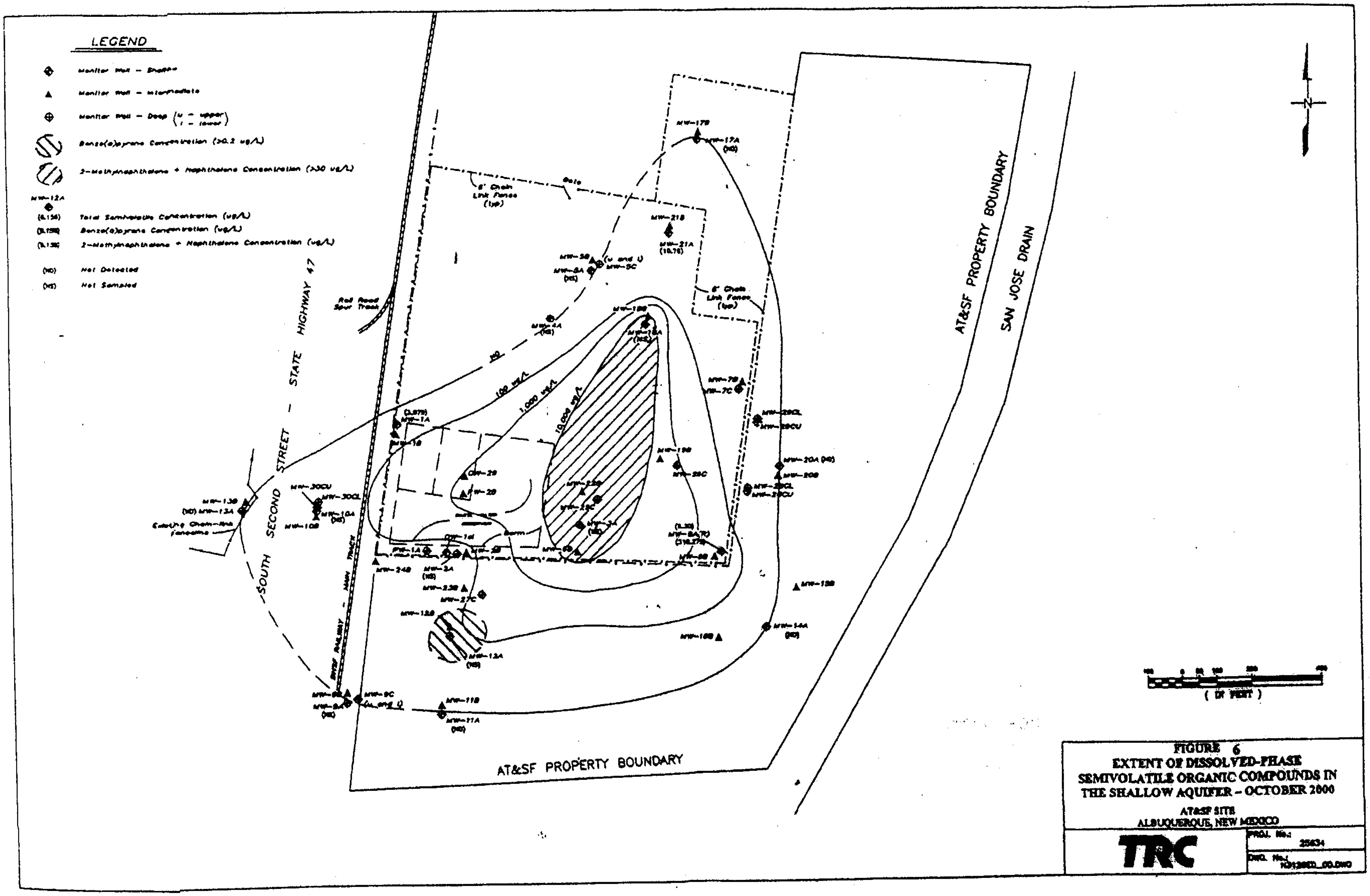


FIGURE 6
EXTENT OF DISSOLVED-PHASE SEMIVOLATILE ORGANIC COMPOUNDS IN THE SHALLOW AQUIFER – OCTOBER 2000

AT&SF SITE
ALBUQUERQUE, NEW MEXICO

TRC

PROJ. No.: 25634

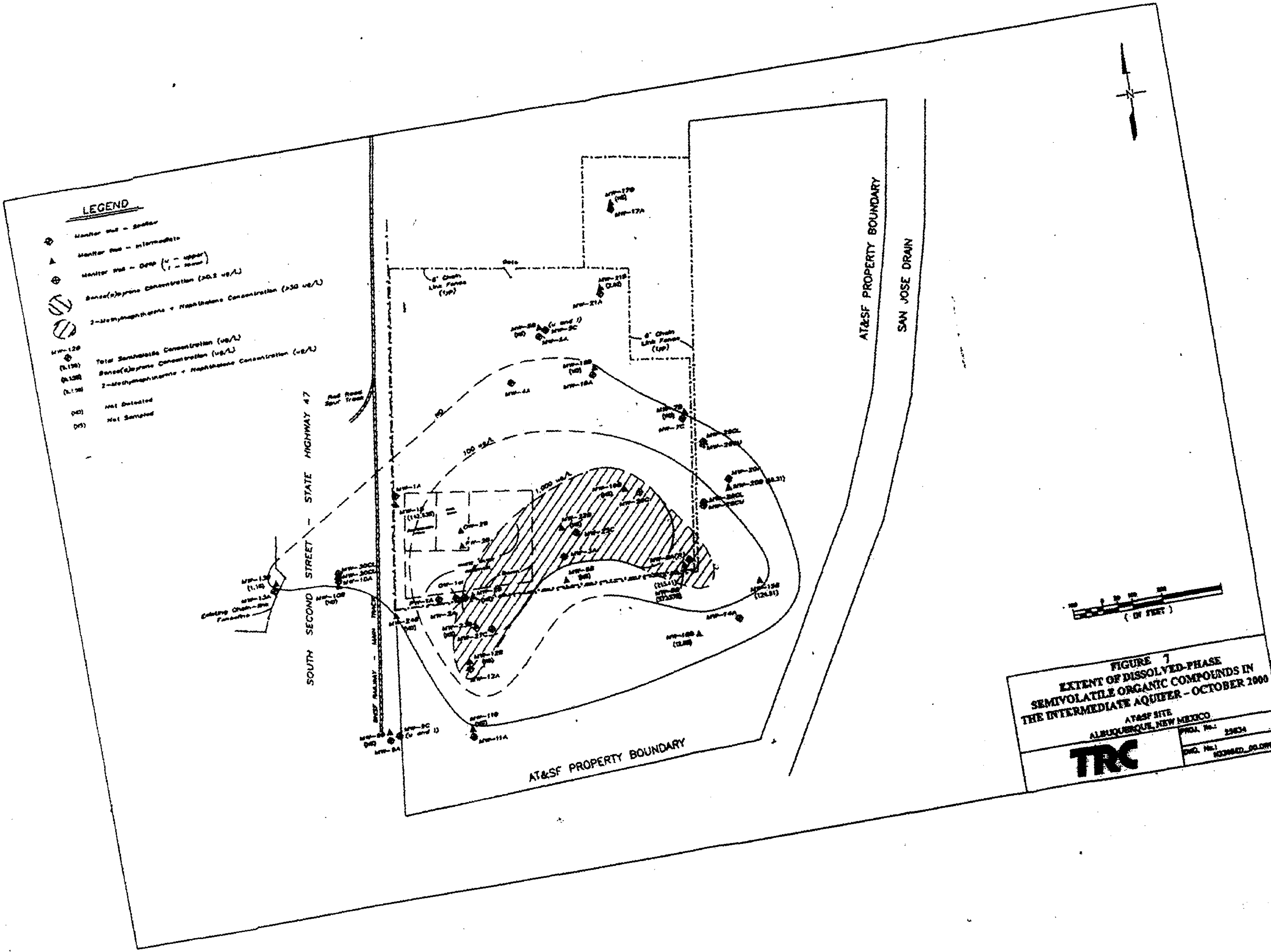
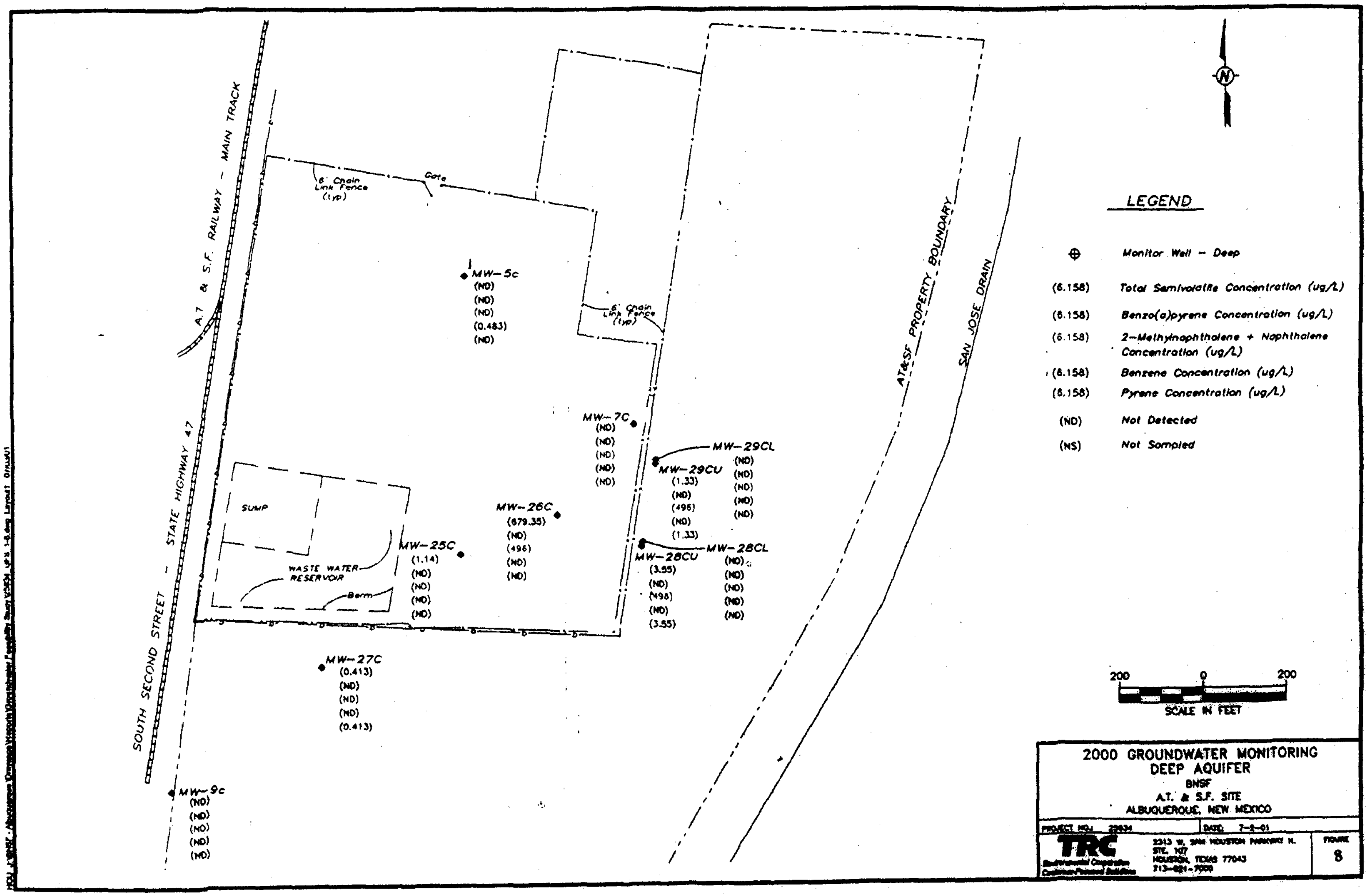


FIGURE 7
EXTENT OF DISSOLVED-PHASE SEMIVOLATILE ORGANIC COMPOUNDS IN THE INTERMEDIATE AQUIFER – OCTOBER 2000
AT&SF SITE
ALBUQUERQUE, NEW MEXICO



A.T. & S.F. RAILWAY - MAIN TRACK
SOUTH SECOND STREET - STATE HIGHWAY 47
AT&SF PROPERTY BOUNDARY
SAN JOSE DRAIN
6' Chain Link Fence (typ)
Gate
SUMP
WASTE WATER RESERVOIR
Berm
MW-5c (ND) (ND) (ND) (0.483) (ND)
MW-7C (ND) (ND) (ND) (ND) (ND)
MW-29CL (ND) (ND) (ND) (ND) (ND)
MW-29CU (1.33) (ND) (496) (ND) (1.33)
MW-26C (679.35) (ND) (496) (ND) (ND)
MW-25C (1.14) (ND) (ND) (ND) (ND)
MW-28CU (3.55) (ND) (498) (ND) (3.55)
MW-28CL (ND) (ND) (ND) (ND) (ND)
MW-27C (0.413) (ND) (ND) (ND) (0.413)
MW-9c (ND) (ND) (ND) (ND) (ND)
N
LEGEND
Monitor Well - Deep
(6.158) Total Semivolatile Concentration (ug/L)
(6.158) Benzo(a)pyrene Concentration (ug/L)
(6.158) 2-Methylnaphthalene + Naphthalene Concentration (ug/L)
(6.158) Benzene Concentration (ug/L)
(6.158) Pyrene Concentration (ug/L)
(ND) Not Detected
(NS) Not Sampled
200 0 200
SCALE IN FEET
2000 GROUNDWATER MONITORING
DEEP AQUIFER
BNSF
A.T. & S.F. SITE
ALBUQUERQUE, NEW MEXICO
PROJECT NO.: 29634
DATE: 7-2-01
TRC
2313 W. SAM HOUSTON PARKWAY N.
STE. 107
HOUSTON, TEXAS 77043
713-821-7000
FIGURE
8

TABLES

Table 1

Summary of Chemicals of Concern and Medium-Specific Exposure Point Concentrations

AT&SF Albuquerque Superfund Site

Scenario Timeframe: Current/Future

Exposure Point	Medium	Chemical of Concern	Conc. Detected		Units	Frequency of Detection	Exposure Point Concentration	Exposure Point Concentration Units	Statistical Measure
			Min	Max					
Ditch	Surface Soil	Zinc	35.4	511	mg/kg	100%	511	mg/kg	Max
		Benz(a)anthracene	0.0268	3.21	mg/kg	73%	3.21	mg/kg	Max
		Benz(a)pyrene	0.0929	3.07	mg/kg	55%	3.07	mg/kg	Max
		Benzo(b)fluoranthene	0.0485	8.56	mg/kg	73%	8.56	mg/kg	Max
		Benzo(k)fluoranthene	0.0485	8.56	mg/kg	73%	8.56	mg/kg	Max
		Dibenz(a,h)anthracene	0.0474	0.693	mg/kg	18%	0.693	mg/kg	Max
		Dibenzofuran	0.0823	0.568	mg/kg	36%	0.568	mg/kg	Max
		Indeno(1,2,3-c,d)pyrene	0.0295	1.61	mg/kg	64%	1.61	mg/kg	Max
		2-Methylnaphthalene	0.0519	0.369	mg/kg	45%	0.369	mg/kg	Max
		Naphthalene	0.0354	0.872	mg/kg	55%	0.872	mg/kg	Max
Tie Treatment Area and WWR Area	Surface and Subsurface Soil	Zinc	8.26	7,650	mg/kg	92%	7,650	mg/kg	Max
		Benz(a)anthracene	0.0844	566	mg/kg	41%	566	mg/kg	Max
		Benz(a)pyrene	0.0474	1,200	mg/kg	33%	1,200	mg/kg	Max
		Benzo(b)fluoranthene	0.0985	300	mg/kg	36%	300	mg/kg	Max
		Benzo(k)fluoranthene	0.0662	200	mg/kg	36%	200	mg/kg	Max
		Dibenz(a,h)anthracene	0.797	6.67	mg/kg	5%	6.67	mg/kg	Max
		Dibenzofuran	0.08	1,900	mg/kg	40%	1,900	mg/kg	Max
		Indeno(1,2,3-c,d)pyrene	0.0664	350	mg/kg	31%	350	mg/kg	Max
		2-Methylnaphthalene	0.0984	1,800	mg/kg	28%	1,800	mg/kg	Max
		Naphthalene	0.0953	3,500	mg/kg	40%	3,500	mg/kg	Max
Deep Aquifer Off-Site	Ground Water	Benzene	0.0335	0.0335	ug/l	25%	0.0335	ug/l	Max
		Dibenzofuran	1.81	4.95	ug/l	50%	4.95	ug/l	Max
		2-Methylnaphthalene	5.55	5.55	ug/l	25%	5.55	ug/l	Max
		Naphthalene	23.6	23.6	ug/l	25%	23.6	ug/l	Max
Shallow Aquifer On-Site	Ground Water	Benzene	0.0505	120	ug/l	68%	120	ug/l	Max
		Benz(a)anthracene	0.329	1.15	ug/l	23%	1.15	ug/l	Max
		Benz(a)pyrene	0.165	0.165	ug/l	3%	0.165	ug/l	Max
		Benzo(b)fluoranthene	0.242	0.242	ug/l	3%	0.242	ug/l	Max
		Benzo(k)fluoranthene	0.319	0.319	ug/l	3%	0.319	ug/l	Max
		Bis(2-ethylhexyl) phthalate	12.7	966	ug/l	5%	966	ug/l	Max
		Carbazole	121	479	ug/l	67%	479	ug/l	Max
		Chrysene	0.325	22.9	ug/l	23%	22.9	ug/l	Max
		Dibenzofuran	0.225	303	ug/l	45%	303	ug/l	Max
		2-Methylnaphthalene	394	901	ug/l	33%	901	ug/l	Max
		Naphthalene	0.758	14,400	ug/l	45%	14,400	ug/l	Max
Intermediate Aquifer On-Site	Ground Water	Benzene	0.0543	240	ug/l	64%	240	ug/l	Max
		Benz(a)anthracene	3.72	98.7	ug/l	12%	98.7	ug/l	Max
		Benz(a)pyrene	1.01	31.6	ug/l	12%	31.6	ug/l	Max
		Benzo(b)fluoranthene	1.29	32.8	ug/l	12%	32.8	ug/l	Max
		Benzo(k)fluoranthene	0.79	26.2	ug/l	12%	26.2	ug/l	Max
		Bis(2-ethylhexyl) phthalate	0.463	534	ug/l	9%	534	ug/l	Max
		Carbazole	11	11	ug/l	50%	11	ug/l	Max
		Chrysene	0.761	88.3	ug/l	15%	88.3	ug/l	Max
		Dibenz(a,h)anthracene	4.25	4.25	ug/l	4%	4.25	ug/l	Max
		Dibenzofuran	3.12	582	ug/l	88%	582	ug/l	Max
		Indeno(1,2,3-c,d)pyrene	2.92	8.63	ug/l	7%	8.63	ug/l	Max
		2-Methylnaphthalene	0.799	680	ug/l	27%	680	ug/l	Max
		Naphthalene	0.944	12,800	ug/l	42%	12,800	ug/l	Max
Deep Aquifer On-Site	Ground Water	Benzene	0.0474	0.158	ug/l	38%	0.158	ug/l	Max
		Carbazole	32.3	32.3	ug/l	50%	32.3	ug/l	Max
		Dibenzofuran	44.8	76.6	ug/l	50%	76.6	ug/l	Max
		2-Methylnaphthalene	25.5	59.4	ug/l	50%	59.4	ug/l	Max
		Naphthalene	606	1,120	ug/l	50%	1,120	ug/l	Max

KEY

mg/kg: milligrams per kilograms
ug/l: microgram per liter
MAX: Maximum Concentration
Reference: Human Health Risk Assessment Tables 2.1, 2.2, 2.3, 2.4, 2.9, 2.10, 2.11, 2.12, 2.13

This table presents the chemicals of concern (COCs) and exposure point concentrations for each of the COCs that could be detected for ground water and soil. This table includes the range of concentration detected for each COC, as well as the frequency of detection in ground water samples, the exposure point concentration (EPC), and the basis for derivation of the EPC.

TABLE 2
CANCER TOXICITY DATA - ORAL/DERMAL
AT&SF Albuquerque Superfund Site
Albuquerque, New Mexico

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor	Adjusted Dermal Cancer Slope Factor (1)	Units	Weight of Evidence/ Cancer Guideline Description	Type of Cancer	Sources of Slope Factor/Target Organ	Date
INORGANICS								
Arsenic	1.50E+00	0.7	2.14E+00	$mg/kg/d^{-1}$	A	Liver, kidney, lung, bladder	IRIS	01/18/01
Manganese	NA	0.055	NA		D			
VOLATILES								
Benzene	5.50E-02	0.97	5.67E-02	$mg/kg/d^{-1}$	A	Leukemia	Occup./IRIS	11/22/00
SEMIVOLATILES								
Benzo(a)anthracene (a)	7.30E-01	0.31	2.35E+00	$mg/kg/d^{-1}$	B2	Forestomach	Diet/IRIS	11/22/00
Benzo(a)pyrene	7.30E+00	0.31	2.35E+01	$mg/kg/d^{-1}$	B2	Forestomach	Diet/IRIS	11/22/00
Benzo(b)fluoranthene (a)	7.30E-01	0.31	2.35E+00	$mg/kg/d^{-1}$	B2	Forestomach	Diet/IRIS	11/22/00
Benzo(k)fluoranthene (a)	7.30E-02	0.31	2.35E-01	$mg/kg/d^{-1}$	B2	Forestomach	Diet/IRIS	11/22/00
bis(2-Ethylhexyl)phthalate	1.40E-02	0.31	4.52E-02	$mg/kg/d^{-1}$	B2	Liver	Diet/IRIS	11/22/00
Carbazole	2.00E-02	0.31	6.45E-02	$mg/kg/d^{-1}$	B2	Liver	Diet/HEAST	FY97, July
Chrysene (a)	7.30E-03	0.31	2.35E-02	$mg/kg/d^{-1}$	B2	Forestomach	Diet/IRIS	11/22/00
Dibenzofuran	NA	0.31	NA		D			
Dibenz(a,h)anthracene (a)	7.30E+00	0.31	2.35E+01	$mg/kg/d^{-1}$	B2	Forestomach	Diet/IRIS	11/22/00
Indeno(1,2,3-cd)pyrene (a)	7.30E-01	0.31	2.35E+00	$mg/kg/d^{-1}$	B2	Forestomach	Diet/IRIS	11/22/00
Methylnaphthalene, 2-	NA	0.31	NA					
Naphthalene	NA	0.31	NA		C			
Phenanthrene	NA	0.31	NA		D			
DIOXINS/FURANS								
TCDD-TEQ	1.5E+05	0.31	4.84E+05	$mg/kg/d^{-1}$	B2	Respiratory System, Liver	Diet/HEAST	FY97, July

(a) Cancer slope factor for Benzo(a)pyrene with appropriate TEF applied.
(1) SFd = SFo / Oral to Dermal Adj. Factor
IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables

EPA Group:
- A - Human carcinogen
- B1 - Probable human carcinogen - indicates that limited human data are available
- B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
- C - Possible human carcinogen
- D - Not classifiable as a human carcinogen
- E - Evidence of noncarcinogenicity

Weight of Evidence:
- Known/Likely
- Cannot be Determined
- Not Likely

TABLE 2a
CANCER TOXICITY DATA - INHALATION
AT&SF Albuquerque Superfund Site
Albuquerque, New Mexico

Chemical of Potential Concern	Unit Risk	Units	Adjustment	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Type of Cancer	Sources of Slope Factor: Target Organ	Date: [illegible]
INORGANICS									
Arsenic	4.30E-03	$(ug/m^3)^{-1}$	3.50E+03	1.51E+01	$mg/kg/d^{-1}$	A	Lung	Occup./IRIS	1/18/01
Manganese	NA			NA		D			
VOLATILES									
Benzene	7.71E-06	$(ug/m^3)^{-1}$	3.50E+03	2.70E-02	$mg/kg/d^{-1}$	A	Leukemia	Occup./IRIS	11/22/00
SEMIVOLATILES									
Benzo(a)anthracene	NA			NA		B2			
Benzo(a)pyrene	NA			NA		B2			
Benzo(b)fluoranthene	NA			NA		B2			
Benzo(k)fluoranthene	NA			NA		B2			
bis(2-Ethylhexyl)phthalate	NA			NA		B2			
Carbazole	5.71E-06	$(ug/m^3)^{-1}$	3.50E+03	2.00E-02	$mg/kg/d^{-1}$	B2	Liver	Diet/HEAST	FY97, July
Chrysene	NA			NA		B2			
Dibenzofuran	NA			NA		D			
Dibenz(a,h)anthracene	NA			NA		B2			
Indeno(1,2,3-cd)pyrene	NA			NA		B2			
Methylnaphthalene, 2-	NA			NA					
Naphthalene	NA			NA		C			
Phenanthrene	NA			NA		D			
DIOXINS/FURANS									
TCDD-TEQ	3.21E-02	$(ug/m^3)^{-1}$	4.67E+06	1.50E+05	$mg/kg/d^{-1}$	B2	Respiratory System, Liver	Diet/HEAST	FY97, July

IRIS = Integrated Risk Information System
HEAST= Health Effects Assessment Summary Tables

Weight of Evidence:
Known/Likely
Cannot be Determined

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 3
NON-CANCER CHRONIC TOXICITY DATA -- INHALATION
AT&SF Albuquerque Superfund Site
Albuquerque, New Mexico

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD	Units	Primary Target Organ/ Effects	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (2) (MM/DD/YY)
INORGANICS									
Arsenic		NA							
Manganese	Chronic	5.00E-05	mg/m^3	1.43E-05	mg/kg-d	Neurobehavioral functions	1000	Occup./IRIS	1/18/01
VOLATILES									
Benzene		NA		NA					
SEMIVOLATILES									
Benzo(a)anthracene		NA		NA					
Benzo(a)pyrene		NA		NA					
Benzo(b)fluoranthene		NA		NA					
Benzo(k)fluoranthene		NA		NA					
bis(2-Ethylhexyl)phthalate		NA		NA					
Carbazole		NA		NA					
Chrysene		NA		NA					
Dibenzofuran	Chronic	1.40E-02	mg/m^3	4.00E-03	mg/kg-d			EPA Region VI MSCs	Sep-00
Dibenz(a,h)anthracene		NA		NA					
Indeno(1,2,3-cd)pyrene		NA		NA					
Methylnaphthalene, 2- (a)	Chronic	3.00E-03	mg/m^3	8.57E-04	mg/kg-d	Upper Respiratory Tract	3000	Inhalation/IRIS	11/22/00
Naphthalene	Chronic	3.00E-03	mg/m^3	8.57E-04	mg/kg-d	Upper Respiratory Tract	3000	Inhalation/IRIS	11/22/00
Phenanthrene (a)		NA		NA					
DIOXINS/FURANS									
TCDD-TEQ		NA		NA					

(a) Cross-assigned from Naphthalene
N/A = Not Applicable

TABLE 3a
NON-CANCER SUB-CHRONIC TOXICITY DATA -- INHALATION
AT&SF Albuquerque Superfund Site

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ/ Effects	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD: Target Organ	Dates (2) (MM/DD/YY)
INORGANICS									
Arsenic		NA		NA					
Boron	Sub-Chronic (1)	2.00E-02	mg/m^3	5.71E-03	mg/kg/d	Respiratory Tract	100	Inhalation/HEAST	FY97, July
Cadmium		NA		NA					
Copper		NA		NA					
Mercury (a)	Sub-Chronic (1)	3.00E-04	mg/m^3	8.57E-05	mg/kg/d	Autonomic Nervous System	30	Occup./IRIS	11/22/00
Tin		NA		NA					
Zinc		NA		NA					
VOLATILES									
Acetone		NA		NA					
Benzene		NA		NA					
Carbon tetrachloride		NA		NA					
Ethylbenzene	Sub-Chronic (1)	1.00E+00	mg/m^3	2.86E-01	mg/kg/d	Developmental Effects	300	Inhalation/IRIS	11/22/00
Methylene chloride	Sub-Chronic	3.00E+00	mg/m^3	8.57E-01	mg/kg/d	Liver	100	Inhalation/HEAST	FY97, July
Toluene	Sub-Chronic	4.00E+00	mg/m^3	1.14E+00	mg/kg/d	Neurological effects	300	Occup./IRIS	1/18/01
Xylene, Total		NA		NA					
SEMIVOLATILES									
Acenaphthene		NA		NA					
Acenaphthylene		NA		NA					
Anthracene		NA		NA					
Benzo(a)anthracene		NA		NA					
Benzo(a)pyrene		NA		NA					
Benzo(b)fluoranthene		NA		NA					
Benzo(g,h,i)perylene		NA		NA					
Benzo(k)fluoranthene		NA		NA					
Carbazole		NA		NA					
Chrysene		NA		NA					
Di-n-butylphthalate		NA		NA					
Dibenzofuran	Sub-Chronic (1)	1.40E-02	mg/m^3	4.00E-03	mg/kg/d			EPA Region VI MSCs	Sep-00
Dibenz(a,h)anthracene		NA		NA					
Fluoranthene		NA		NA					
Fluorene		NA		NA					
Indeno(1,2,3-cd)pyrene		NA		NA					
Methylnaphthalene, 2- (b)	Sub-Chronic (1)	3.00E-03	mg/m^3	8.57E-04	mg/kg/d	Upper Respiratory Tract	3000	Inhalation/IRIS	11/22/00
N-Nitrosodiphenylamine		NA		NA					
Naphthalene	Sub-Chronic (1)	3.00E-03	mg/m^3	8.57E-04	mg/kg/d	Upper Respiratory Tract	3000	Inhalation/IRIS	11/22/00
Phenanthrene (b)	Sub-Chronic (1)	NA		NA			3000	Inhalation/IRIS	11/22/00
Phenol		NA		NA					
Pyrene		NA		NA					
DIOXINS/FURANS									
TCDD-TEQ		NA		NA					

(a) As elemental mercury
(b) Cross-assigned from Naphthalene
N/A = Not Applicable
(1) Provide equation used for derivation in text.
(2) For IRIS values, provide the date IRIS was searched.
For HEAST values, provide the date of HEAST.
For NCEA values, provide the date of the article provided by NCEA.

TABLE 3b
NON-CANCER CHRONIC TOXICITY DATA - ORAL/DERMAL
AT&SF Albuquerque Superfund Site
Albuquerque, New Mexico

Chemical of Potential Concern	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor	Ref.	Adjusted Dermal RfD (1)	Units	Primary Target Organ/ Effects	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
INORGANICS										
Arsenic	3.00E-04	mg/kg-d	0.7	ATSDR	2.10E-04	mg/kg-d	Keratosis, vasculare	3	Oral/IRIS	1/18/01
Manganese	1.40E-01	mg/kg-d	0.055	ATSDR	7.70E-03	mg/kg-d	CNS	1	Diet/IRIS	1/18/01
VOLATILES										
Benzene	NA		0.97	ATSDR	NA					
SEMIVOLATILES										
Benzo(a)anthracene	NA		0.31	ATSDR	NA					
Benzo(a)pyrene	NA		0.31	ATSDR	NA					
Benzo(b)fluoranthene	NA		0.31	ATSDR	NA					
Benzo(k)fluoranthene	NA		0.31	ATSDR	NA					
bis(2-Ethylhexyl)phthalate	1.40E-02	mg/kg-d	0.25	ATSDR	3.50E-03	mg/kg-d	None Observed	N/A	EPA, REG. VI	Sep-00
Carbazole	NA		0.7	ATSDR	NA					
Chrysene	NA		0.31	ATSDR	NA					
Dibenzofuran	4.00E-03	mg/kg-d	0.5	ATSDR	2.00E-03	mg/kg-d			EPA Region VI MSCs	Sep-00
Dibenz(a,h)anthracene	NA		0.31	ATSDR	NA					
Indeno(1,2,3-cd)pyrene	NA		0.31	ATSDR	NA					
Methylnaphthalene, 2- (a)	2.00E-02	mg/kg-d	0.8	ATSDR	1.60E-02	mg/kg-d	Body Weight	3000	Oral/IRIS	11/22/00
Naphthalene	2.00E-02	mg/kg-d	0.8	ATSDR	1.60E-02	mg/kg-d	Body Weight	3000	Oral/IRIS	11/22/00
Phenanthrene (a)	2.00E-02	mg/kg-d	0.31	ATSDR	6.20E-03	mg/kg-d	Body Weight	3000	Oral/IRIS	11/22/00
DIOXINS/FURANS										
TCDD-TEQ	NA		0.19	ATSDR	NA					

(a) Cross-assigned from Naphthalene
N/A = Not Applicable
(1) RfDd = RfDo x Oral to Dermal Adj. Factor

TABLE 3c
NON-CANCER SUB-CHRONIC TOXICITY DATA -- ORAL/DERMAL
AT&SF Albuquerque Superfund Site
Albuquerque, New Mexico

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor	Ref	Adjusted Dermal RfD (2)	Units	Primary Target Organ Effects	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3) (MM/DD/YY)
INORGANICS											
Arsenic	Subchronic (1)	3.00E-04	mg/kg-d	0.7	ATSDR	2.10E-04	mg/kg-d	Keratosis, vasculare	3	Oral/IRIS	1/18/01
Boron	Subchronic (1)	#REF!	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Male reproductive System	100	Diet/IRIS	11/22/00
Cadmium	Subchronic (1)	1.00E-03	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Kidney	10	Diet/IRIS	11/22/00
Copper (a)	Subchronic (1)	#REF!	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d			Oral/HEAST	FY97, July
Mercury (b)	Subchronic	3.00E-03	mg/kg-d	0.2	ATSDR	6.00E-04	mg/kg-d	Autoimmune Effects	100	Diet/HEAST	FY97, July
Tin	Subchronic (1)	6.00E-01	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Liver, Kidney	100	Diet/HEAST	FY97, July
Zinc	Subchronic (1)	3.00E-01	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Decrease in EOSE	3	Diet/IRIS	1/18/01
VOLATILES											
Acetone	Subchronic	1.00E+00	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Increased liver and kidney weights	1000	Oral/IRIS	1/18/01
Benzene		NA		0.97	ATSDR	NA					
Carbon tetrachloride	Subchronic (1)	7.00E-04	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Liver	1000	Oral/IRIS	11/22/00
Ethylbenzene	Subchronic (1)	1.00E-01	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Liver and Kidney	1000	Oral/IRIS	11/22/00
Methylene chloride	Subchronic (1)	6.00E-02	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Liver	100	Water/IRIS	FY97, July
Toluene	Subchronic	2.00E+00	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Liver and Kidney	1000	Oral/IRIS	1/18/01
Trichlorofluoromethane	Subchronic	7.00E-01	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Increased Mortality	1000	Oral/HEAST	FY97, July
Xylene, o	Subchronic (1)	2.00E+00	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Increased Mortality, CNS, Decreased body weight	100	Oral/IRIS	11/22/00
Xylene, Total	Subchronic (1)	2.00E+00	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Increased Mortality, CNS, Decreased body weight	100	Oral/IRIS	11/22/00
SEMIVOLATILES											
Acenaphthene	Subchronic	6.00E-01	mg/kg-d	0.31	ATSDR	1.86E-01	mg/kg-d	Liver	300	Oral/HEAST	FY97, July
Acenaphthylene		NA		0.31	ATSDR	NA					
Anthracene	Subchronic	3.00E+00	mg/kg-d	0.31	ATSDR	9.30E-01	mg/kg-d	None Observed	300	Oral/HEAST	FY97, July
Benzo(a)anthracene		NA		0.31	ATSDR	NA					
Benzo(a)pyrene		NA		0.31	ATSDR	NA					
Benzo(b)fluoranthene		NA		0.31	ATSDR	NA					
Benzo(g,h,i)perylene		NA		0.31	ATSDR	NA					
Benzo(k)fluoranthene		NA		0.31	ATSDR	NA					
Carbazole		NA		0.7	ATSDR	NA					
Chrysene		NA		0.31	ATSDR	NA					
Di-n-butylphthalate	Subchronic	1.00E+00	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Increased Mortality	100	Diet/HEAST	FY97, July
Dibenzofuran	Subchronic (1)	4.00E-03	mg/kg-d	0.31	ATSDR	1.24E-03	mg/kg-d			EPA Region VI MSCs	Sep-00
Dibenz(a,h)anthracene		NA		#REF!	ATSDR	NA					
Fluoranthene	Subchronic	4.00E-01	mg/kg-d	0.31	ATSDR	1.24E-01	mg/kg-d	Liver, Blood, Clinical Signs	300	Oral/HEAST	FY97, July
Fluorene	Subchronic	4.00E-01	mg/kg-d	0.5	ATSDR	2.00E-01	mg/kg-d	Blood	300	Oral/HEAST	FY97, July
Indeno(1,2,3-cd)pyrene		NA		0.8	ATSDR	NA					
Methylnaphthalene, 2- (c)	Subchronic (1)	2.00E-02	mg/kg-d	0.31	ATSDR	6.20E-03	mg/kg-d	Body Weight	3000	Oral/IRIS	11/22/00
N-Nitrosodiphenylamine		NA		#REF!	ATSDR	NA					
Naphthalene	Subchronic (1)	2.00E-02	mg/kg-d	0.8	ATSDR	1.60E-02	mg/kg-d	Body Weight	3000	Oral/IRIS	11/22/00
Phenanthrene (c)	Subchronic (1)	2.00E-02	mg/kg-d	0.31	ATSDR	6.20E-03	mg/kg-d	Body Weight	3000	Oral/IRIS	11/22/00
Phenol	Subchronic	6.00E+00	mg/kg-d	#REF!	ATSDR	#REF!	mg/kg-d	Reduced fetal body weights	100	Oral/IRIS	1/18/01
Pyrene	Subchronic	3.00E-01	mg/kg-d	0.31	ATSDR	9.30E-02	mg/kg-d	Kidney	300	Oral/HEAST	FY97, July
DIOXINS/FURANS											
TCDD-TEQ		NA		0.19	ATSDR	NA					

(a) Calculated from current drinking water standard
(b) As Mecuric Chloride
(c) Cross-assigned from Naphthalene
N/A = Not Applicable
(1) Cross-assigned from chronic values
(2) RfDd = RfDo x Oral to Dermal Adj. Factor
(3) Subchronic values presented only for COCs in Future Utility and Excavation Scenario

Table 4
Cost of Selected Remedy S-8 In-situ solidification/stabilization and run-off/run-on management
AT&SF Albuquerque Superfund Site
Costs Prepared by TRC Solutions

task	unit	unit cost	quantity	cost		
General						
Supervision	week	4800	18	$ 86,400.00		
Project manager	week	3840	18	$ 69,120.00		
Superintendent	week	2200	18	$ 39,600.00		
Engineer	week	2720	18	$ 48,960.00		
Technicians	week	2200	30	$ 66,000.00		
					$ 310,080.00	
Temporary facilities						
office trailer	month	600	5	$ 3,000.00		
storage trailer	month	600	5	$ 3,000.00		
portable toilet	month	120	5	$ 600.00		
electric hook up	ls	5000	1	$ 5,000.00		
site security	day	350	120	$ 42,000.00		
surveying	day	650	90	$ 58,500.00		
mob/demob	ls	10000	1	$ 10,000.00		
misc supplies	ls	16000	1	$ 8,000.00		
ppe	ls	12000	1	$ 12,000.00		
					$ 142,100.00	
Site Access Control						
Signs	lf	300	1	$ 300.00		
Decon						
decon pad construction	ls	10000	1	$ 10,000.00		
pressure washer	ls	4000	1	$ 4,000.00		
water treatment plant	ls	12000	1	$ 12,000.00		
				$ -		
Clear and grub	acre	600	3	$ 1,800.00		
Well abandonment	ea	1200	15	$ 18,000.00		
excavation		1.74	5,134	$ 8,933.16		
S/S	sheet 3					
process	cy (clu-in)	$ 80.00	5603	$ 448,240.00		
1' clay cap						
Clay Cap	CY	$ 13.86	1486	$ 20,595.96		
crushed stone			old volume * 1.3 increase			
crushed stone	CY	$ 22.96	1531	$ 35,151.76		$ 51,821.87
stone placement	sy	$ 3.28	4330	$ 14,202.40	rough grading 17 03 0101	
backfill WWR	cy	6.79	17136.00	$ 116,353.44		
backfill excavation	cy	6.79	5134	$ 34,859.86		
verification sampling		24000	1	$ 24,000.00		
construction testing		25000	1	$ 25,000.00		
final grading and seeding		2000	3	$ 6,000.00		
soil treatment contingency 20%				$ 118,396.63		
disposal of IDW		275	100	$ 27,500.00		
O&M, 7% discount rate						
10% area for 2 yrs	cy	6.79	4 x a year	$ 18,491.72	p/a @7%=1.80835	
density testing 1/yr/10 yr	each	151.97		$ 1,069.12	p/a @7%=7.0351	
phyto upkeep 4xyr/ 10 yr	acre	60.16	1.25	$ 2,116.16	p/a @7%=7.0351	
					$ 21,677.00	
Project Cost				$ 1,399,190.21		
contingency (20%)				$ 279,838.04		
Contractor Overhead (6%)				$ 83,951.41		
Contractor Profit (7%)				$ 97,943.31		
Total				$ 1,860,922.98		
NM 5% tax				$ 93,046.15		
Project TOTAL				$ 1,953,969.12		

Table 4a
Estimated Cost of DNAPL Contaminated Soil Incineration
AT&SF Albuquerque Superfund Site

task	unit	unit cost	quantity	cost
Decon				
decon pad construction	ls	10000	1	$ 10,000.00
pressure washer	ls	4000	1	$ 4,000.00
DNAPL excavation	cy	3.25	1,000	$ 3,250.00
Incinerator				
Incinerator	ton	$ 500.00	1000	$ 500,000.00
transportation	ton	$ 150.00	1000	$ 150,000.00
fuel surcharge				$ 20,000.00
Ash Disposal (landfill)	ton	$ 50.00	300	$ 15,000.00
backfill excavated area	cy	6.79	1000	$ 6,790.00
verification sampling		12000	1	$ 12,000.00
disposal of IDW		275	25	$ 6,875.00
Project Cost				$ 727,915.00
contingency (20%)				$ 145,583.00
Total				$ 873,498.00
NM 5% tax				$ 43,674.90
Project TOTAL				$ 917,172.90

Note: This estimate is based on 1,000 tons of DNAPL contaminated soil. The actual amount will be determined during the implementation of the Preferred Alternate S-8. Any DNAPL contaminated soil that is encountered during the excavation process will be segregated and transported for disposal at an approved incinerator.

Table 5
Summary Cost of Ground Water Remedial Options
AT&SF Albuquerque Superfund Site
Costs Prepared by TRC Solutions

SUMMARY (w/tax)

350 gpm SYSTEM:	Capital Cost, $	Annual O&M Cost $, Years 1 - 3	Annual O&M Cost $, Years 4 - 30	NPV, 7% discount rate, 30 years	Capital Cost, $/gallon	O&M cost, $/1000 gal, Year 1 - 3	O&M cost, $/1000 gal, Year 4 - 30
Alternate GW-2: UV-Oxidation	$10,284,880	$2,113,522	$1,654,522	$32,020,407	$20.41	$11.49	$8.99
Alternate GW-3: FBR	$13,495,771	$1,549,404	$1,090,404	$28,231,151	$26.78	$8.42	$5.93
Alternate GW-4: Clay/carbon	$10,132,291	$2,474,315	$2,015,315	$36,344,891	$20.10	$13.45	$10.96
Alternate GW-5: Steam Flushin(	$27,080,043	$3,194,895	$2,422,695	$59,169,761	$53.73	$17.37	$13.17
Alternate GW-7: In-situ Oxidatic	$12,634,737	$2,026,900	$1,260,100	$30,283,640	$25.07	$11.02	$6.85

Note: If P&T for Alternate GW-5 stops at year 5, NPV = $39,039,589
Note: If P&T for Alternate GW-7 stops at year 5, NPV = $19,813,472
Note: If P&T for Alternate GW-2 stops at year 5, NPV = $19,170,987

Cost factor = **1.08** Includes 5% tax and 3% contingency

DNAPL Cost Difference: Years 1-3 vs years 4-30:
560,000 - 135,000 = **$425,000**
$425,000 x 1.08 = **$459,000**

Alt GW-5 Delta O&M = **$772,200**

Alt GW-7 Delta O&M = **$766,800**

SUMMARY (w/tax)

500 gpm SYSTEM:	Capital Cost, $	Annual O&M Cost $, Years 1 - 3	Annual O&M Cost $, Years 4 - 30	NPV, 7% discount rate, 30 years	Capital Cost, $/gallon	O&M cost, $/1000 gal, Year 1 - 3	O&M cost, $/1000 gal, Year 4 - 30
Alternate GW-2: UV-Oxidation	$12,739,140	$2,037,852	$1,578,852	$33,535,676	$17.69	$7.75	$6.01
Alternate GW-3: FBR	$16,716,240	$1,449,938	$990,938	$30,217,348	$23.22	$5.52	$3.77
Alternate GW-4: Clay/carbon	$12,550,140	$2,363,612	$1,904,612	$37,389,036	$17.43	$8.99	$7.25
Alternate GW-5: Steam Flushin(	$33,542,100	$3,362,769	$2,590,569	$67,714,968	$46.59	$12.80	$9.86
Alternate GW-7: In-situ Oxidatic	$15,649,740	$1,967,868	$1,201,068	$32,566,118	$21.74	$7.49	$4.57

DNAPL Cost Difference: Years 1-3 vs years 4-30:
560,000 - 135,000 = **$425,000**
$425,000 x 1.08 = **$459,000**

Alt GW-5 Delta O&M = **$772,200**

Alt GW-7 Delta O&M = **$766,800**

Notes:
COST DRIVERS (sensitivities) for the alternates:

1 Assumed need for UV light and peroxide with hydraulically induced cavitation.
2 Assumed off-gas treatment of fixed film bio-system required for volatiles or odors.
3 Eleven changeouts of carbon and clay with clay/GAC adsorber system; could be less depending upon load. Other alternates assume 4 changes per year of GAC. No GAC adsorbers used on FBR-GAC system.
4 FBR units could be reduced in size if organic load is less at influent point. FBR costs influenced not only by hydraulics, but organic loading.
5 Slightly high O&M cost factor on UV-peroxide system due to lamp replacement costs.
6 Disposal cost on clay adsorber material assumed - could be higher.
7 Disposal cost on concentrated DNAPL based on verbal quote of $0.30 to $0.40 /lb based on BTU content and. hazardous constituents; need to add transportation.
8 DNAPL and O&G emulsion amount for disposal drive O&M costs. Assumed less material in years 4 - 30, however amount was reduced from 2.5% based on flow to 0.60% which could be low. Used $0.34/lb for both transport and disposal costs.
9 Normal analytical monitoring for 30 year period to be added to above table options based on E.T's "No Action" NPV costs ($90,000 per year first 5 years, $60,000 per year second five years)

Table 5a
Detailed Cost of Ground Water Remedial Options
AT&SF Albuquerque Superfund Site
Costs Prepared by TRC Solutions

	Equipment: (common to all trains)	**Base Capital Cost for 500 gpm system, $**	**Base Capital Cost for 350 gpm system, $**	
1	Skimmer tank and Air flotation unit for O&G / DNAPL, rated 350 gpm	355,000	286,607	$355,000*(350/500)^0.60 = $286,607
2	IAF float tk & pump, rated 10 gpm	17,000	13,725	
3	Concentrated DNAPL Separator, rated 75 gpm	65,500	52,881	
4	DNAPL Storage Tk	55,000	44,404	
5	DNAPL transfer pumps	18,000	14,532	
6	EQ - Jet mixer system	67,000	54,092	
7	Equalization Tank (covered)	75,000	60,551	
8	Scrubber System	130,000	104,955	
9	Vapor phase carbon canisters	37,000	29,872	
10	Misc. chemical feed tanks	30,000	24,220	
11	KMnO4 feed system	12,000	9,688	
12	pH / Polymer feed systems	33,000	26,642	
13	Building	90,000	72,661	
14	EQ.Trans. pumps & rapid mix	100,000	80,734	
15	Clarifier & sludge tk	200,000	161,469	
16	Treatment system - SEE *ALTERNATIVES below:*			
17	Filter feed tank	20,000	16,147	
18	Filter feed pumps	45,000	36,330	
19	Filtration	98,000	79,120	
20	Clearwell / treated water tk.	62,000	50,055	
21	Re-injection pumps	53,000	42,789	
22	Sludge Dewatering: Precoat VF system with supersack feeders	295,000	238,167	
	Sludge pumps	20,000	16,147	
23	Filtrate tank & pumps	75,000	60,551	
24	System Piping	375,000	302,754	
25	25,000 ft @ $15/ft		0	
26	Flow meters & control valves	76,000	61,358	
27	MCC Equipment & wire racks	58,000	46,826	
28	Facility air compressor	32,500	26,239	
29	Line Insulation	45,000	36,330	
30	Utility gas lines & water	70,000	56,514	
31	DCS System / MMIs	27,000	21,798	
32	SCADA System	15,000	12,110	
33	Capitalized commissioning supplies	85,000	85,000	*similar cost*
34	Structural Steel	72,000	58,129	
35	Site Improvements	20,000	16,147	
	Subtotal:	**$2,828,000**	**$2,299,546**	

Alternative Treatment Train Costs	Equipment 500 gpm System	Equipment 350 gpm System
Alt. GW-2		
UV-oxidation		
Base:	475,000	370,052
GAC filter	50,000	38,953
GAC Ads.	150,000	116,858
W-Carbon	30,000	23,372
Misc.	4,000	3,116
Instrumentation / flowmeters	20,000	15,581
Equipment Subtotal:	729,000	567,932
Alt. GW-3		
FBR-GAC		
Base:	1,800,000	1,402,301
Clarifier	135,000	105,173
filter:	50,000	38,953
W-Carbon	0	0
Misc.	4,000	3,116
Instrumentation / flowmeters	20,000	15,581
Equipment Subtotal:	2,009,000	1,565,123
Alt. GW-4		
Clay - Carbon		
Piping, Valves	35,000	27,267
Base: 2-Adsorbers, 20,000 #	150,000	116,858
Ch. Tk	75,000	58,429
Clay Filters	150,000	116,858
Ch. Tk	75,000	58,429
Clay guard filter	64,000	49,860
Clay:	60,000	46,743
Carbon for Ads. $0.70/#	30,000	23,372
Misc.	4,000	3,116
Flow meters	16,000	12,465
Equipment Subtotal:	659,000	513,398
Alt. GW-5		
In-situ Steam Stripping		
Per Steamtech:		
I.A. Source zone, only	$12,000,000	$12,000,000
I.A. Dissolved Plume (total)	$25,000,000	$25,000,000
Upgrade their system to FBR	1,000,000	1,000,000
Misc.	4,000	4,000
Flow meters	16,000	16,000
Equipment Subtotal:	26,020,000	26,020,000

Alt GW-7

In-Situ Oxidation (Ozone)		500 gpm system $ = 350 gpm system $
SVE Odor control extraction well & equip.	75,000	
Inlet air filters		
Air Compressor		
Piping / distribution manifold		
Inlet Air cooler & Air Dryer		
Cooling water System		
Ozone Generator	945,000	Confirm
Power supply / freq. converter		
Transformer		
Ozone Conc, Monitor		
Ambient ozone monitor		
Dew Point Monitor		
PLC unit / process controls	20,000	
Misc.	4,000	
40 injection wells @ $5,500	220,000	220,000
System Piping	350,000	Confirm
Equipment Subtotal:	1,614,000	

Additional costs:		
Modeling (hydraulic)	$60,000,	
Surveying	3,500	
Foundation Soil Tests / Study	7,500	
Permitting/fees	72,000	
Public Notice/community meet.	12,000	
Legal	90,000	
Development / Bank fees	80,000	
Lender's consultant	50,000	
Interest during construction	125,000	
BNSF Admin.	50,000	
Outside engineering	168,000	
TRC Engineering	360,000	
TRC Project management	107,500	
Maintenance Reserve	300,000	**Assume $300,000 initial maintenance reserve to offset major maintenance in later years**
Subtotal:	1,425,500	

Phy./Chem.Treatabiltiy Studies:		
Elect.R.Tm. Sub. Imaging	45,000	2002 Baseline
Onsite Expenses	17,000	
Cavitation:	33,000	
Ozonation	42,000	
Induced Air flotation	26,000	
Overall Process / metals removal	25,000	
Analytical (for above)	135,000	
TRC Review	20,000	
Waste Disposal	35,000	
Subtotal:	378,000	

Biological Treatability Studies	
Phase I Toxicity	10,000
Phase II Treatability	40,000
Phase III Loading Adjustments	15,000
Analytical	65,000
Onsite Expenses/utilities	25,000
TRC Coordination/Review	38,000
Waste Disposal	35,000
Subtotal:	193,000

Wells: 316 ss		$4,500 per MB for PVC
Plume control		
10 injection @ $5,500	55,000	
20 extraction @ $5,500	110,000	
20 pumps at $1,500	30,000	
Spare Pumps, controllers	18,000	
Subtotal:	213,000	

500 gpm System	**500 gpm Base Equipment Cost**	**500 gpm Technology Equip. Cost**	**Plume Control Well System**	**Treatability Sudy cost**	**Equip. Capital Cost ***
Alt. GW-2 - UV-oxidation	2,828,000	729,000	213,000	378,000	4,148,000
Alt. GW-3 - FBR-GAC	2,828,000	2,009,000	213,000	571,000	5,621,000
Alt. GW-4 - Clay - Carbon	2,828,000	659,000	213,000	378,000	4,078,000
Alt. GW-5 - In-situ Steam Stri	2,828,000	26,020,000	213,000	571,000	29,632,000
Alt. GW-7 - In-Situ Oxidation	2,828,000	1,614,000	213,000	571,000	5,226,000

: Alt GW-5 is installed cost

	Eng. & Fees	Equip. Capital Cost	500 gpm Installed Cost (2.5 multiplier on Equipment cost)	Total Project Installed Cost	Detail Eng. As % of Cost	Detail Eng. & Management As % of Cost
Alt. GW-2 - UV-oxidation	1,425,500	$4,148,000	$10,370,000	$11,795,500	4.5	5.4
Alt. GW-3 - FBR-GAC	1,425,500	$5,621,000	$14,052,500	$15,478,000	3.4	4.1
Alt. GW-4 - Clay - Carbon	1,425,500	$4,078,000	$10,195,000	$11,620,500	4.5	5.5
Alt. GW-5 - In-situ Steam Stri	1,425,500	$29,632,000	----	31,057,500	1.7	2.0
Alt. GW-7 - In-Situ Oxidation	1,425,500	$5,226,000	$13,065,000	$14,490,500	3.6	4.4

Assumptions: 500 gpm and 350 gpm treatment systems

Treatment Train flows:
6 wells at 2.5 gpm/well = 15 gpm of DNAPL emulsion & water, assume 2.5% DNAPL:
Therefore, 0.375 gpm DNAPL = 540 gallons/day = 197,100 gals/year (4,503 lbs/day)
Assume 2.5% DNAPL first three years, thereafter assume 0.6% DNAPL emulsion (130 gallons/day)

Use 7 to 10 extraction wells
Plume Treament Wells: 260 gpm total (includes chemical additions)
Treatment Train return streams = 45 gpm
DNAPL Future reserve capacity = 30 gpm
Total Flow: (15 + 260 + 45 + 30) = 350 gpm

Hazardous Waste Disposal: 350 gpm system
Typical Incineration cost = $400/ton plus transportation
Verbal Quote from USA Environmental for creosote, Houston, TX = $0.50/lb
or $1,000 per ton.

Assume we can get quantity discount; $0.34/lb or $680/ton, including transportation.

Cost per lb, $	0.34			
DNAPL gals/day, yrs 1 - 3	540		822	tons/year
DNAPL gals/day, yrs 4 - 30	130		198	tons/year

Yearly cost (years 1 - 3) =	558,897	Use:	$560,000	For 350 gpm total system
Yearly cost (years 4 - 30) =	134,549	Use:	$135,000	

Difference between Years 1-3 and 4-30 is $1,500,000 - 450,000 = $425,000

500 gpm system:
Assume same as above; more flow capacity for plume control, but same overall DNAPL production.

500 gpm System
ANNUAL O&M Costs:

Alternate GW-2: power & cherr	520,000		
Alt. GW-2 W-carbon (4 change	120,000		
Labor	305,800	Includes 39% burden on $220,000	
Maint. @ 7.5% of equipment	311,100	7.5% used due to lamp replacements	
Misc. / subcontract / supplies	25,000		
Oil and solids disposal	45,000	Non-hazardous assumed	
DNAPL disposal	560,000	Use decreased cost in years 4-30	$135,000
Subtotal:	**1,886,900**		
Alternate GW-3: power & chemicals	208,000		
Alt. GW-3 W-carbon (makeup only)	2,000		
Labor	305,800	Includes 39% burden on $220,000	
Maint. @ 3.5% of equipment	196,735		
Misc. / subcontract / supplies	25,000		
Oil and solids disposal	45,000	Non-hazardous assumed	
DNAPL disposal	560,000	Use decreased cost in years 4-30	$135,000
Subtotal:	**1,342,535**		
Alternate GW-4: power & chemicals			
Alt. GW-4 clay (11 / yr)	660,000		
Alt. GW-4 W-carbon (11 / yr)	330,000		
Labor	305,800	Includes 39% burden on $220,000	
Maint. @ 3.5% of equipment	142,730		
Misc. / subcontract / supplies	25,000		
Oil and solids disposal	45,000	Non-hazardous assumed	
DNAPL disposal	560,000	Use decreased cost in years 4-30	$135,000
Clay Disposal	120,000		
Subtotal:	**2,188,530**		

Alternate GW-5: Steam Stripping			Use decreased cost in years 4-30		
Fuel & power	550,000	**Confirm**	Estimate	260,000	total
Labor	305,800		Above grd P&T = $208,000		
Maint. @ 0.5% of Proj.cost	1,552,875				
Misc. / subcontract / supplies	100,000				
Oil and solids disposal	45,000	Non-hazardous assumed			
DNAPL disposal	560,000	Use decreased cost in years 4-30			$135,000
Subtotal:	**3,113,675**				
		Note: Years 4-30: Decrease in O&M =			$715,000

Note: Assume 7 years of treatment after first 3 years of steam flushes: 10 total for first option

Alternate GW-7: In-situ Oxidation			
Adjunct chemicals	75,000	**Confirm** peroxide	
Power & Water	550,000	**Confirm** Above grd P&T = $208,000	
Labor	305,800	Includes 39% burden on $220,000	
Maint. @ 5.0% of equipment	261,300		
Misc. / subcontract / supplies	25,000		
Oil and solids disposal	45,000	Non-hazardous assumed	
DNAPL disposal	560,000	Use decreased cost in years 4-30	$135,000
Subtotal:	**1,822,100**		

Use decreased cost in years 4-30
Estimate 265,000 total power
Above grd P&T = $208,000
Note: Years 4-30: Decrease in O&M = $710,000

Note: Assume 7 years of treatment after first 3 years of oxidation flushes: 10 total for first option
Assume 27 years of treatment after first 3 years of oxidation flushes: 30 total for second option

Present Worth Factors:	
(P/A, 7%, 30 years) =	12.409
(P/A, 7%, 3 years) =	2.624
(P/A, 7%, 15 years) =	9.108
(P/A, 7%, 10 years) =	7.042
(P/A, 7%, 7 years) =	5.389
(P/A, 7%, 5 years) =	4.1
(P/A, 7%, 4 years) =	3.387

Difference in O&M O&G and DNAPL disposal (later years) = **$425,000**

Year 2001 Dollars (no escalation)

500 gpm SYSTEM:	Installed Capital Cost, $	Annual O&M Cost, Years: 1-3, $	Annual O&M Cost, Years: 4-30, $	NPV, 7% discount rate, 30 years	Based on 720,000 gpd Capital Cost, $/gallon	Year 1-3 O&M cost, $/1000 gal	Year 4-30 O&M cost, $/1000 gal
Alternate GW-2: UV-Oxidation	$11,795,500	1,886,900	1,461,900	$31,051,551	$16.38	$7.18	$5.56
Alternate GW-3: FBR	$15,478,000	1,342,535	917,535	$27,979,026	$21.50	$5.11	$3.49
Alternate GW-4: Clay/carbon	$11,620,500	2,188,530	1,763,530	$34,619,478	$16.14	$8.33	$6.71
Alternate GW-5: Steam Flushin	$31,057,500	3,113,675	2,398,675	$62,699,044	$43.14	$11.85	$9.13
Alternate GW-7: In-situ Oxidati	$14,490,500	1,822,100	1,112,100	$30,153,813	$20.13	$6.93	$4.23

Note: If P&T for Alternate GW-5 stops at year 15, NPV = $54,781,018
Note: If P&T for Alternate GW-5 stops at year 10, NPV = $49,825,355
Note: If P&T for Alternate GW-5 stops at year 7, NPV = $45,860,346
Note: If P&T for Alternate GW-5 stops at year 5, NPV = $42,768,453

Also: may not have to run option 9 for 30 years
Note: If P&T for Alternate GW-7stops at year 10, NPV = $24,185,173

O&M
350 GPM System COSTS **Maintenance Reserve = 300,000 X 0.807 = $242,100**

	Factored Equipment Cost		Maintenance factor, %	Equipment Maintenance Cost
		Cost of 500 gpm system x (350/500)^0.6 Multiplier = 0.807344		
Alternate				
Alternate GW-2: UV-Oxidation	$3,348,863		7.5	$251,165
Alternate GW-3: FBR	$4,538,081		3.5	$158,833
Alternate GW-4: Clay/carbon	$3,292,349		3.5	$115,232
Alternate GW-5: Steam Flushin	$23,923,217	Installed	0.05 of project	1,267,436
Alternate GW-7: In-situ Oxidati	$4,219,180		5.0	$210,959
350 gpm System				

ANNUAL O&M Costs:			
Alternate GW-2: power & chem	$520,000		
Alt. GW-2 W-carbon (4 change	$120,000		
Labor	$305,800	Includes 39% burden on $220,000	
Maint. @ 7.5% of equipment	$251,165	I due to lamp replacements	
Misc. / subcontract / supplies	$50,000		
Oil / Solids disposal	$45,000		
DNAPL disposal	$560,000	Use decreased cost in years 4-30	135,000
Subtotal:	**$1,851,965**		
Alternate GW-3: power & chem	$208,000		
Alt. GW-3 W-carbon (makeup c	$2,000		
Labor	$305,800	Includes 39% burden on $220,000	
Maint. @ 3.5% of equipment	$158,833		
Misc. / subcontract / supplies	$50,000		
Oil / Solids disposal	$45,000		
DNAPL disposal	$560,000	Use decreased cost in years 4-30	135,000
Subtotal:	**$1,329,633**		
Alternate GW-4: power & chemicals			
Alt. GW-4 clay (11 / yr)	$660,000		
Alt. GW-4 W-carbon (11 / yr)	$330,000		
Labor	$305,800	Includes 39% burden on $220,000	
Maint. @ 3.5% of equipment	$115,232		
Misc. / subcontract / supplies	$50,000		
Oil / Solids disposal	$45,000		
DNAPL disposal	$560,000	Use decreased cost in years 4-30	135,000
Clay Disposal	$120,000		
Subtotal:	**$2,186,032**		
Alternate GW-5: Steam Stripping		Use decreased cost in years 4-30	
Fuel & power	$550,000	**Confirm** Estimate $260,000.00	total
Labor	$305,800	Above grd P&T = $208,000	
Maint. @ 0.5% of Proj.cost	$1,267,436		
Misc. / subcontract / supplies	$125,000		
Oil / Solids disposal	$45,000		
DNAPL disposal	$560,000	Use decreased cost in years 4-30	135,000
Subtotal:	**$2,853,236**		
		Total decrease in O&M Cost =	$715,000

Alternate GW-7: In-situ Oxidation			
Adjunct chemicals	$50,000	**Confirm** Treatment & cooling water	
Power & water use	$550,000	**Confirm** › grd P&T = $208,000	
Labor	$305,800	Includes 39% burden on $220,000	
Maint. @ 5.0% of equipment	$210,959		
Misc. / subcontract / supplies	$50,000		
Oil / Solids disposal	$45,000		
DNAPL disposal	$560,000	Use decreased cost in years 4-30	135,000
Subtotal:	**$1,771,759**		
		Total decrease in O&M Cost = year 4-30 (Dnapl savings & power @ 265,000)	$710,000

NOTES:

1 Assume $300,00 initial maintenance reserve to offset major maintenance in later years
This is included in fees .
Difference in O&M O&G and DNAPL disposal (later years) = $425,000
2 Add $80,000 analytical to each annual O&M alternative cost
3 Add $25,000 Electrical Resistance Tomography - annual scan
4 Year 2001 Dollars (no escalation)

Present Worth Factors:

(P/A, 7%, 30 years) =	12.409
(P/A, 7%, 15 years) =	9.108
(P/A, 7%, 10 years) =	7.042
(P/A, 7%, 7 years) =	5.389
(P/A, 7%, 5 years) =	4.1
(P/A, 7%, 4 years) =	3.387
(P/A, 7%, 3 years) =	2.624

For 350 gpm System:
Assumes 260 gpm from wells
45 gpm from internal recyles & sidestreams
15 gpm initial DNAPL extraction, with aditional 30 gpm capacity

Adjust capital cost based on flow ratios to the 0.6 power
= (500/350)^0.6 = **1.238628**
O&M costs for 350 gpm system noted above Based on 360,000 gpd

Difference in O&M O&G and DNAPL disposal (later years) = $425,000

Table 6
Potentially Applicable or Relevant and Appropriate Requirements (ARARs)

Standard, Requirement, Criteria, Or Limitation	Citation	Description	Media	Rationale & Discussion
Action Specific				
Clean Air Act, 42 U.S.C. § 7401, *et seq.* **New Mexico Air Quality Control Act, N.M. Stat. Ann. § 74-2-1, *et seq.*** **New Mexico Environmental Improvement Act, N.M. Stat. Ann. § 74-1-1, *et seq.***	20 NMAC, Chapter 11 (Bernalillo County, N.M.) 42 U.S.C. § 7411 40 C.F.R. 60.110b	Regulatory requirements for sources of fugitive emissions of particulate matter and emissions of volatile organic compounds (VOCs).	Air	Concentration of particulates and selected VOCs may need to comply with the Bernalillo State Implementation Plan (SIP) regulations at 20 NMAC 11.20 and 20 NMAC 11.65. Activities associated with air stripping extracted ground water may trigger NSPS, Subpart Kb. Emissions from air stripping may trigger other Clean Air Act and NMAQCA standards or requirements.
Resource Conservation and Recovery Act (RCRA), 42 U.S.C. § 6901, *et seq.* **New Mexico Hazardous Waste Act, N.M. Stat. Ann. § 74-4-1, *et seq.*** **New Mexico Solid Waste Act, N.M. Stat. Ann. § 74-9-1, *et seq.***	40 CFR 260, 261, 262, 263, 264, 266, 267, and 268 40 CFR 239 20 NMAC, Chapter 4 20 NMAC, Chapter 9	Generation, collection, transportation, storage, treatment and disposal of solid waste is subject to the requirements of RCRA Subtitles C and D.	Soils & Residuals	Excavation of contaminated soils and its treatment and/or disposal may be subject to RCRA solid and hazardous waste identification and characterization, generation, transportation, treatment, storage, disposal, recycling, and permitting (substantive) requirements. Excavated soils may be subject to land disposal restrictions detailed in 40 CFR 268.30. Any on-site treatment facility will have to meet substantive requirements of 40 CFR 268, including the Minimum Technology Requirement (MTR).

Standard, Requirement, Criteria, Or Limitation	Citation	Description	Media	Rationale & Discussion
Safe Drinking Water Act (SDWA), 33 U.S.C. § 300f, *et seq.* Federal Drinking Water Regulations.	40 CFR 141	SDWA Maximum Contaminant Level Goals (MCLGs).	Ground Water	Ground water will be treated to meet non-zero MCLGs. Where MCLGs are zero, ground water will be treated to meet MCLs. Ground water may need to meet these standards prior to contact with human population.
New Mexico Regulations for Public Drinking Water Systems.	20 NMAC, Ch. 7	State primary drinking water regulations. Health-based maximum contaminant levels (MCLs) for public water systems.		
New Mexico Water Quality Control Commission Regulations.	20 NMAC, Chapter 6, Part 2	Water Quality Control Commission Standards for ground water.		Ground water may need to be restored to these standards, if more stringent than MCLs or MCLGs.
Underground Injection Control (UIC) Regulations.	40 CFR 144-147	Re-injection of treated groundwater would need to comply with substantive provisions of 40 CFR 144-147.		The selected alternative for disposal of treated groundwater is on-site re-injection.

Standard, Requirement, Criteria, Or Limitation	Citation	Description	Media	Rationale & Discussion
Clean Water Act (CWA), 33 U.S.C. § 1251, *et seq.* **CWA National Pollutant Discharge Elimination System (NPDES)**	33 U.S.C. § 1342 40 CFR 122–125	Discharge of effluent to receiving bodies of water must meet the regulations of 40 CFR 122, which establishes limitations and standards for discharge.	Surface Water	An alternative for discharge of treated ground water is to a receiving stream. This discharge would need to meet NPDES criteria.
CWA Water Quality Criteria	40 CFR 131	Criteria for water quality based on toxicity to aquatic organisms and public health.		An alternative for discharge of treated ground water is to a receiving stream. This discharge would need to meet NPDES water quality criteria.
CWA Pretreatment Requirements	40 CFR 403	Discharge of effluent to public works (POTW) must comply with the requirements of 40 CFR 403 as well as any Albuquerque, New Mexico requirements.		Another alternative for discharge of treated ground water is to the POTW.
New Mexico Water Quality Act, **N.M. Stat. Ann. § 74-6-1, *et seq.***				
State of New Mexico Standards for interstate and intrastate streams	20 NMAC, Chapter 6, Part 1	Provides for the protection of surface water through narrative and numerical standards.		Ground water that is discharged to surface water must not degrade the surface water quality.
Location Specific				
Historic Sites Act, 16 USC §§461-467	40 CFR 6.301(a)	Requires Federal agencies to consider the existence and location of landmarks on the National Registry of Natural Landmarks to avoid undesirable impacts upon such landmarks.	Land, Buildings, & Resources	Construction of remedial alternatives will meet this ARAR where designated properties exist.

Standard, Requirement, Criteria, Or Limitation	Citation	Description	Media	Rationale & Discussion
National Historic Preservation Act, **16 U.S.C. §470, *et seq.*** **Archaeological and Historic Preservation Act of 1974, 16 U.S.C. §§469, 469a-1.**	40 CFR §6.301© 36 CFR Part 800	Provides for preservation of historical and archaeological sites, which might be destroyed. Provides for notice/preservation of historic/archaeological sites where terrain is altered as a result of a Federal construction project or a Federally licensed activity or program, or where railroads are moved.	Land, Buildings, & Resources	The Selected Remedy will meet this ARAR by ensuring that construction areas are surveyed for archeological and historic impact and taking any required actions.
Chemical Specific				
New Mexico Cultural Properties Act, N.M. Stat. Ann. § 18-6-1, et seq.	N.M. Stat. Ann. §18-6-1	Requires identification of cultural resources, assessment of impacts on those resources that may be caused by the proposed project, and consultation with the State Historic Preservation Officer.	Land, Buildings, & Resources	Construction of remedial alternatives will meet this ARAR by ensuring that construction areas are surveyed for cultural resources impact.
Safe Drinking Water Act (SDWA), 33 U.S.C. § 300f, *et seq.* Federal Drinking Water Regulations. **New Mexico Regulations for Public Drinking Water Systems.** **New Mexico Water Quality Control Commission Regulations.**	40 CFR 141 20 NMAC, Ch. 7 20 NMAC, Chapter 6, Part 2	SDWA Maximum Contaminant Level Goals (MCLGs). State primary drinking water regulations. Health-based maximum contaminant levels (MCLs) for public water systems. Water Quality Control Commission Standards for ground water.	Ground Water	Ground water will be treated to meet non-zero MCLGs. Where MCLGs are zero, ground water will be treated to meet MCLs. Ground water may need to meet these standards prior to contact with human population. Ground water may need to be restored to these standards, if more stringent than MCLs or MCLGs.

NOTES:

ARAR	Applicable or Relevant and Appropriate Requirements
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
NMAC	New Mexico Administrative Code
NMSA	New Mexico Statutes Annotated
NPDES	National Pollutant Discharge Elimination System
POTW	Publicly Owned Treatment Works
RCRA	Resource Conservation and Recovery Act
USC	United States Code